



SDR Dongle

Our “Eye” to the Wireless World

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2016 Trenton Computer Festival

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Wireless Communication is Not Novel

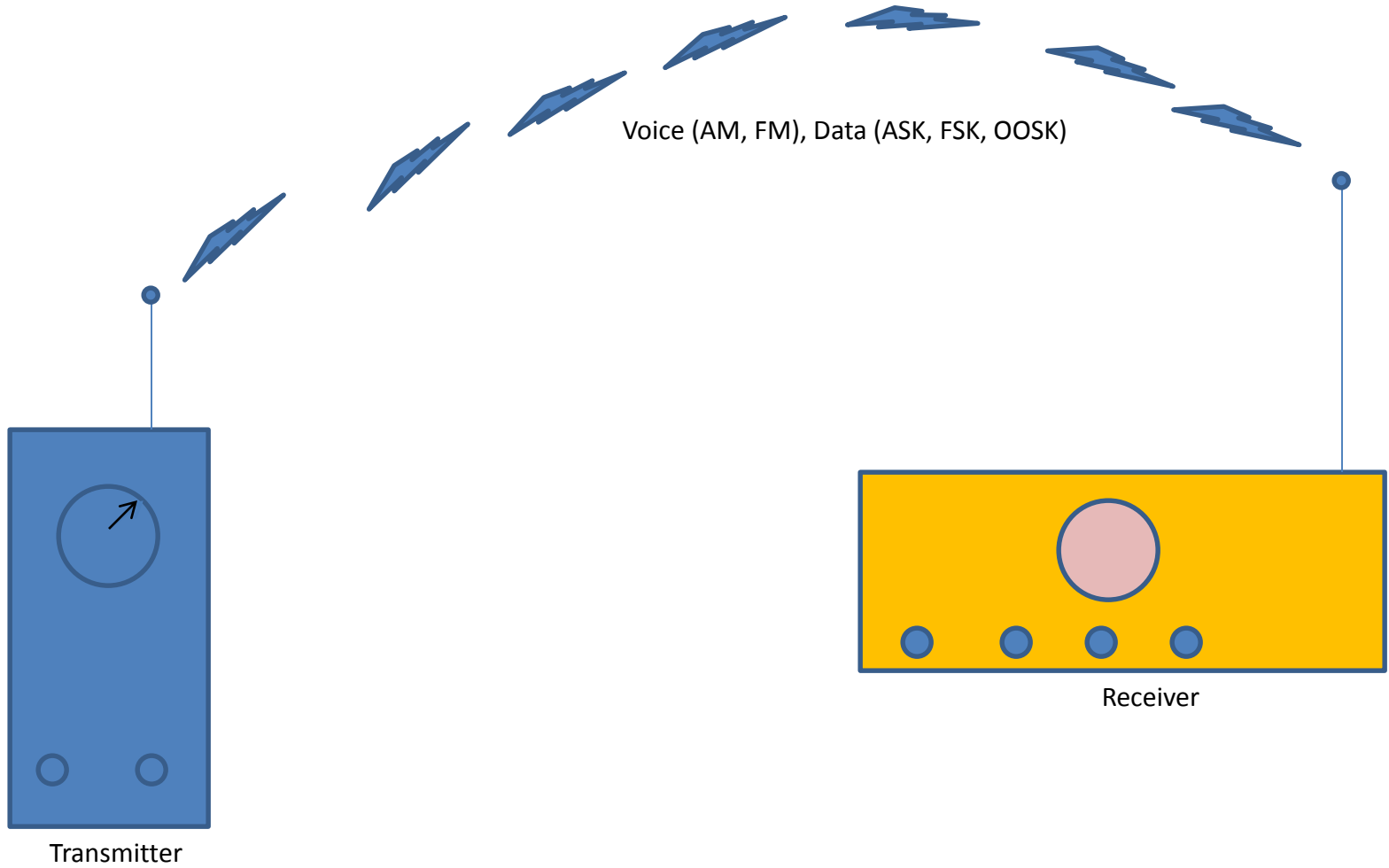
- Speech
- Handwriting
- Sign language
- Whistlers of Gomera Island (Canary Is)
- Body language
- Semaphore
- Smoke signals
- Signal drums
- Mail
- Pony Express
- Homing pigeon
- Road signs
- Pheromones – animal and insect world
- Bugle at reveille



RF Spectrum

- Long wave 150 – 530 KHz
- Medium wave 530 – 1710 KHz
- Short wave (HF) 1.710 – 30 MHz
- VHF 30 – 300 MHz
- UHF 300 – 3000 MHz
- SHF 3000 – 30 GHz

Basic Wireless Device Anatomy



Wireless Devices - Home



54 -216, 470-698 MHz



540-1710 KHz
88-108 MHz



1921-1928 MHz Tx/Rx



Satellite

C band: 3.7-4.2GHz
Ku band: 11.7-12.2 GHz
Subscription sat band: 12.2-12.7 GHz



315 MHz Tx



390.46 MHz Rx



315.6 MHz Rx

315.6 MHz Tx



315 MHz Rx



390.46 MHz Tx



iPod



Wireless Home Devices – Home (Cont'd)



314.449 MHz
Tx



2.432 GHz



915.5 MHz Tx

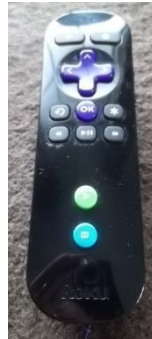
915.5 MHz Rx



900 MHz ISM
(1W) band/2.4
GHz



2.402-2.480 GHz



2.412-2.462 GHz



2.480 GHz



824 – 849 MHz
(2G)



2.412-2.462 GHz



2.4, 5 GHz

Wireless Devices – Vehicles



Ford Fiesta



Console:
AM/FM/Satellite



AM/FM/Satellite Antenna



Sirius/XM Satellite Radio
2.332-2.348 GHz



390.46 MHz Tx



“Smart” Visor for Garage Door/Indoor
Light

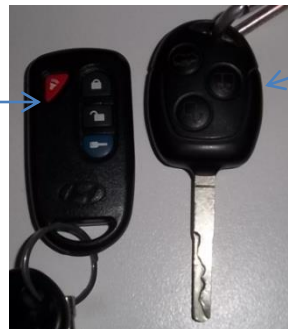


Smart Visor Dipole Antenna



Global Positioning System
1.227/1.575 GHz

434 MHz Tx



Wireless entry, remote starter

315 MHz Tx



FM Wireless Xmitter, 88-108 MHz

Wireless Devices – Vehicles (cont'd)

LoJack - 173.075 MHz

Rear view backup camera – 2.4 GHz

Wireless Sensing Devices: 900 MHz,
2.4 GHz band



TPMS 315, 434 MHz (ASK,FSK)

Wireless Devices – Hobbies



CB: 26.965 – 27.405 MHz



2m ham: 144-148MHz
70 cm ham 440 – 450 MHz



FM Sweep Generator 5-240 MHz



RF Signal Generator: 100 KHz – 54 MHz



FRS/GMRS: 462 & 467MHz



1.8 – 2MHz, 3.5-4 MHz, 7-7.3 MHz, 14-14.35MHz, 21-21.450 MHz, 28-29.7MHz



Micro-drone: courtesy of G. Vaccarino



169.505MHz

Other examples:
Drones – 2.4, 5.8 GHz
R/C cars , boats– 27, 49 MHz, 2.4, 5.8 GHz

Wireless Devices – On the Job



3G Phone



Commercial VHF handheld
144-174 MHz or 450-470 MHz



Wireless keyboard
2.403-2.480 GHz



Wireless mouse



2.405-2.474 GHz
Old mice used 27 MHz band.



Wireless printer
2.412-2.462 GHz

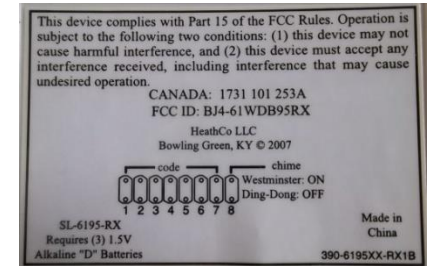
*Old printers used 27 MHz band.
Some now use 5.8 GHz.*



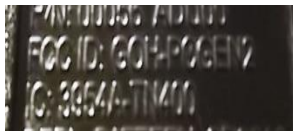
FM wireless microphone
88-108 MHz Tx

What Frequency is My Wireless Device Operating On?

- Look in owner's manual or packaging
- Get FCC ID # from device
- Go to www.fcc.gov and do an FCC ID search
- Frequency counter (moderate \$, range up to 3 GHz)
- Spectrum analyzer (high \$ wide spectrum range)
- RTL-SDR Dongle (low \$, limited to 25 – 1700 MHz)



Note: Put on your Bifocals!



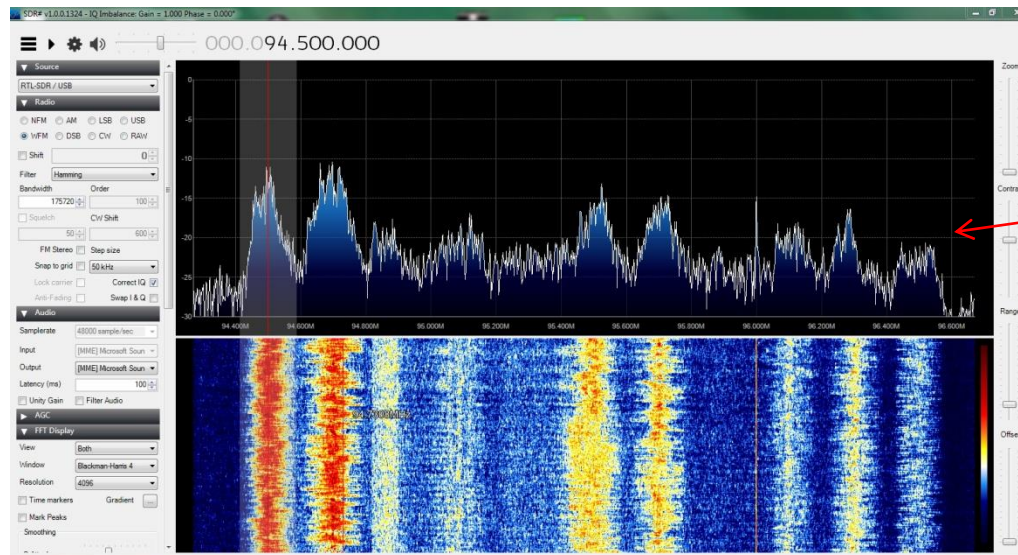
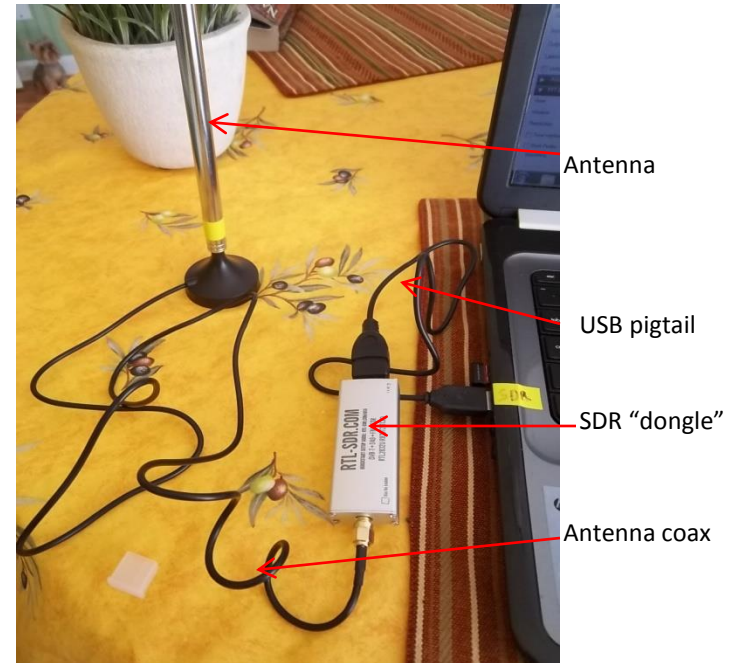
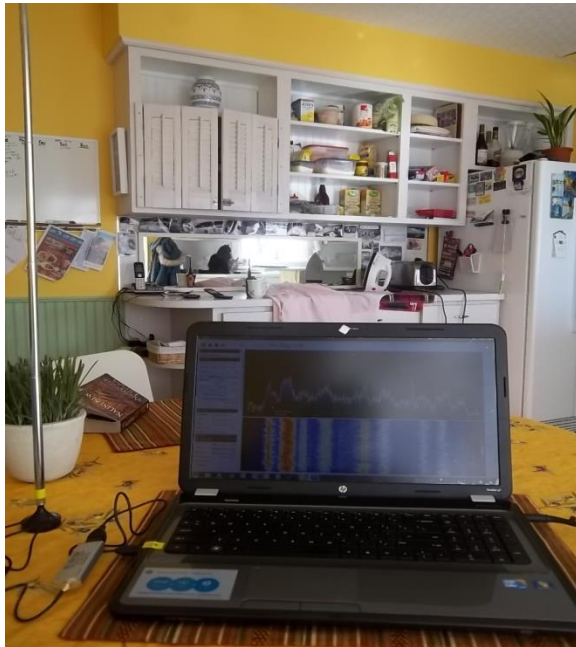
MFJ-866 Frequency Ctr

SDR Dongle



- Small broad band receiver
- Originally designed to receive TV and radio broadcasts in Europe, Africa, Middle East
- Plugs into USB port of computer (some Android apps available)
- Needs driver + software + 5V + antenna to operate
- Not a Plug 'n Play operation
- Covers frequency range 24 – 1700 MHz (Other chipsets, e.g. Elonics tuner 64 – 2300 MHz)
- Low cost – well within a hobbyist's budget
- Available on-line (Nooelec, Amazon, EBay)
- Modes: AM, FM, SSB, CW, some have DRM
- Up to 2 MHz spectrum display
- Waterfall image
- Uses Zadig driver
- Can use SDR#, HDSDR or other software packages such as Touchstone Pro or RTLPanorama
- Useful for looking at waveforms of wireless devices, troubleshooting radio equipment, aligning/restoring radios, looking for bugs, tuning/turning antennas, checking preamp performance

Setting Up a Dongle to View Waveforms

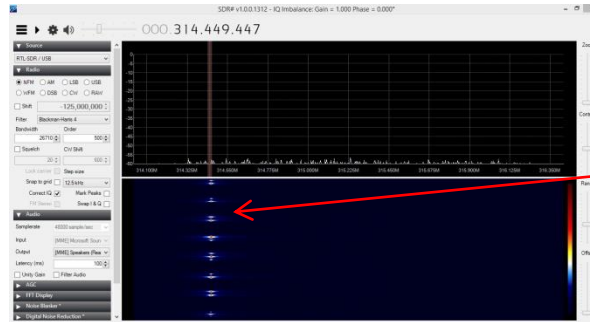


2 MHz scan of FM broadcast band using SDR#

Wireless Device Waveforms - Home



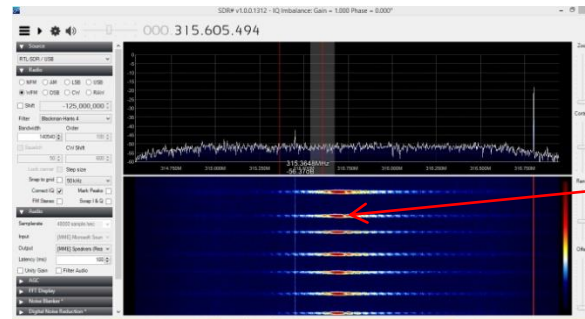
Doorbell



Data burst when button is pressed



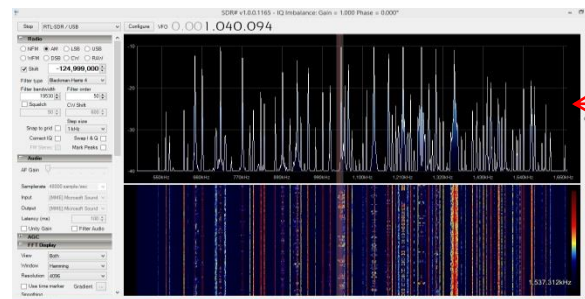
On/Off Switch



Data burst when switching On/Off

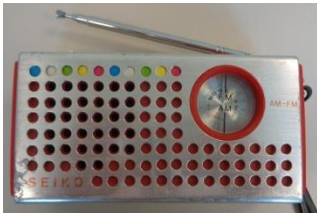


AM/FM Radio

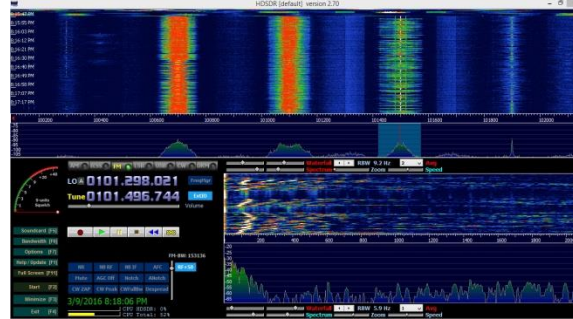


AM Band scan 530 – 1710 KHz

Wireless Device Waveforms – Home (cont'd)



AM/FM Radio



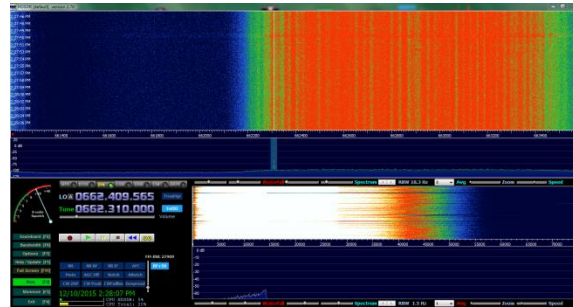
HSDR Software



Touchstone Pro Software



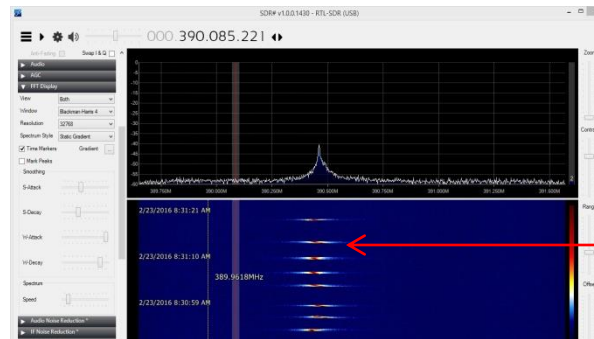
OTA TV



Three different TV channels



Garage door remote



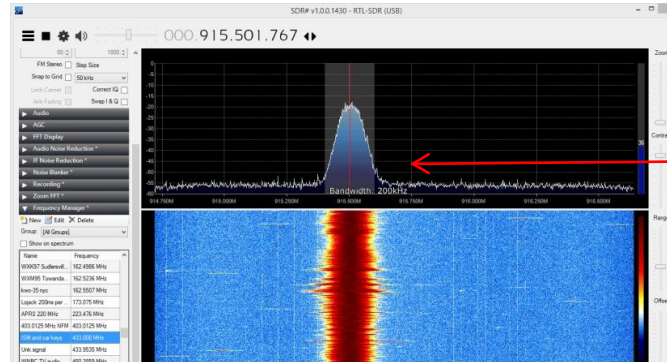
SDR# Software

Data bursts when button is pressed to open/shut door

Wireless Device Waveforms – Home (cont'd)



Sony Wireless Headset



Wireless Wx Display



Remote sensor



FCC ID

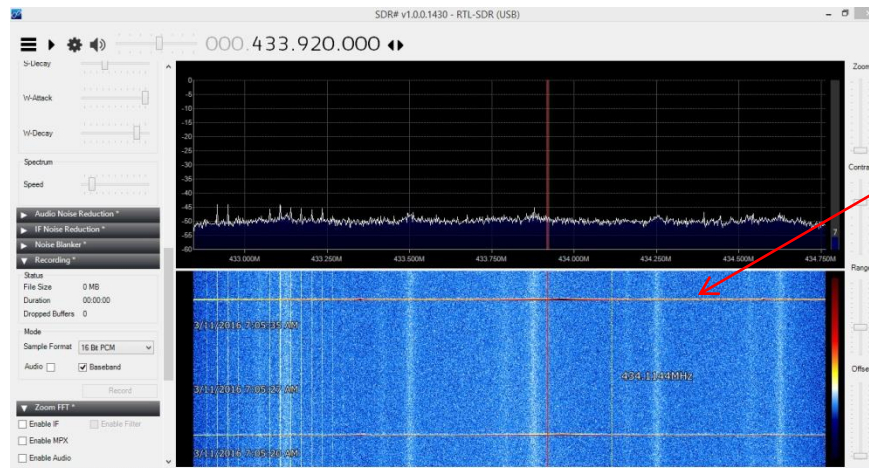


11 Matches found for FCC ID RNERF100VTX

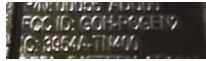
Exhibit Text	File Type	File Size	Description	Submission Date	Permanent	Short Term	Date Available
Block Diagram	Adobe Acrobat PDF	179761	blk diag	02/04/2010	Yes	No	
Cover Letter(s)	Adobe Acrobat PDF	37197	authentication	02/04/2010	No	No	02/09/2010
Cover Letter(s)	Adobe Acrobat PDF	31663	confidentiality	02/04/2010	No	No	02/09/2010
External Photos	Adobe Acrobat PDF	346983	Ext photo	02/04/2010	No	No	02/09/2010
ID Label/Location Info	Adobe Acrobat PDF	142672	label	02/04/2010	No	No	02/09/2010
Internal Photos	Adobe Acrobat PDF	1843786	int photo	02/04/2010	Yes	No	
Operational Description	Adobe Acrobat PDF	20764	opdes	02/04/2010	Yes	No	
Schematics	Adobe Acrobat PDF	172714	schem	02/04/2010	Yes	No	
Test Report	Adobe Acrobat PDF	769595	test report	02/04/2010	No	No	02/09/2010
Test Setup Photos	Adobe Acrobat PDF	391876	Setup photo	02/04/2010	No	No	02/09/2010
Users Manual	Adobe Acrobat PDF	873234	user manual	02/04/2010	No	No	02/09/2010

Courtesy of www.fcc.gov

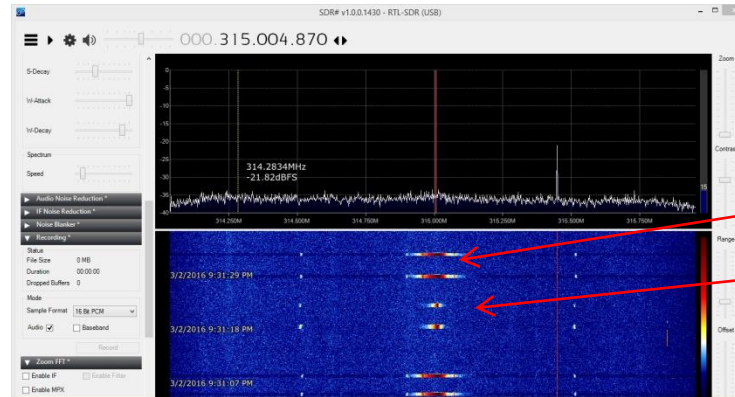
Wireless audio signal from program on TV set



Wireless Device Waveforms - Vehicles

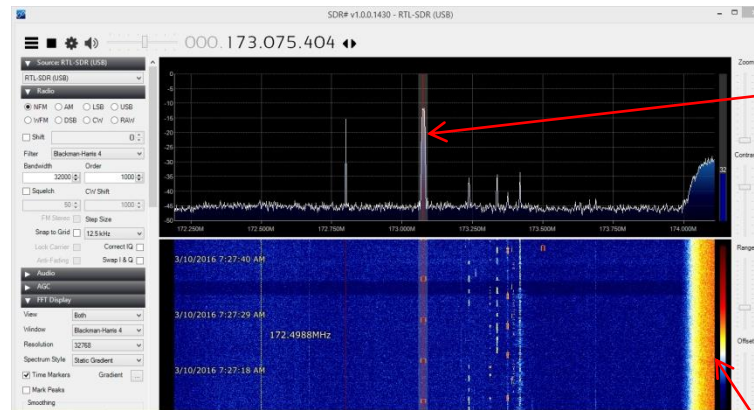


LoJack



Lock

Unlock



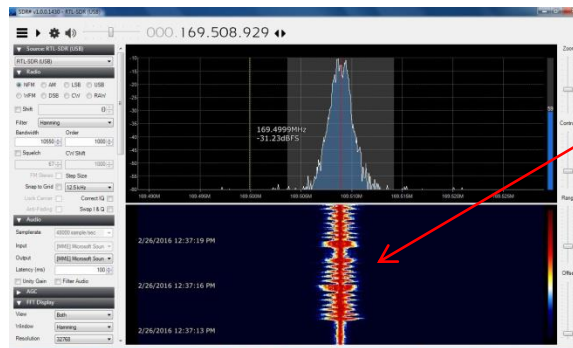
Data burst

Possibly TV Channel 7 (174-180 MHz)

Wireless Device Waveforms - Hobbies



Wireless mic

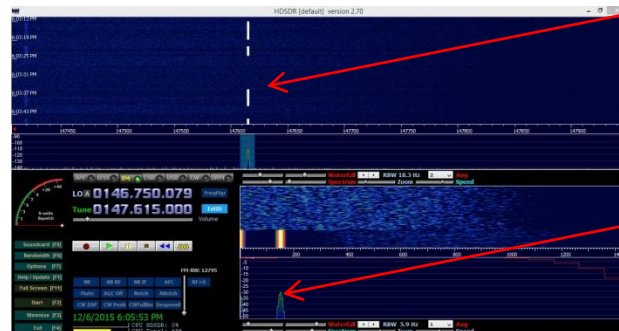


SDR# software

Pronouncing "four" into microphone



Amateur Radio HT



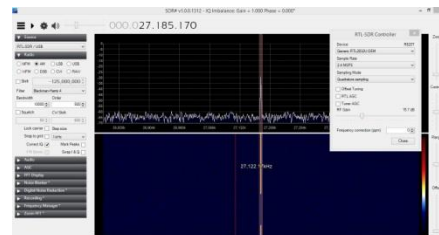
HDSDR Software

Hams talking on 2m

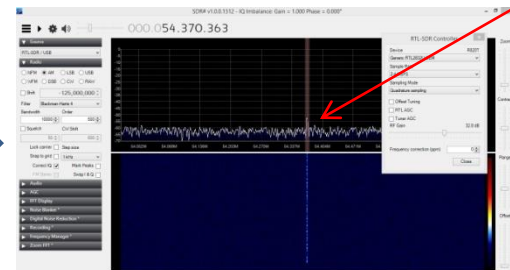
HDSDR audio spectrum analyzer s detects CTCSS (PL) tone



President CB Radio Restoration



Checking Xmitter Accuracy - Ch 19 on 27.185



Checking 2nd Harmonic Suppression

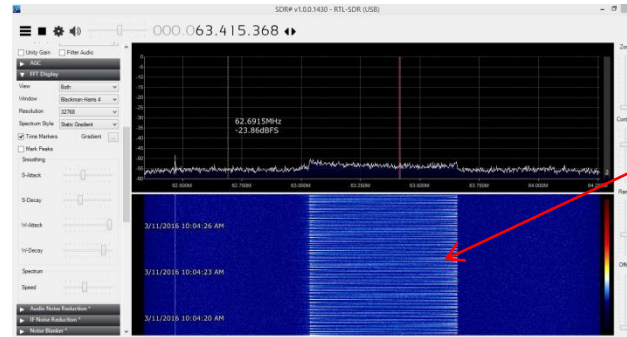
Harmonic Suppression on 54.37 MHz

Wireless Device Waveforms – Hobbies (cont'd)



Vintage Equipment Restoration – Knight KG-652

Checking 63 MHz
"Sweep"



Sweeping

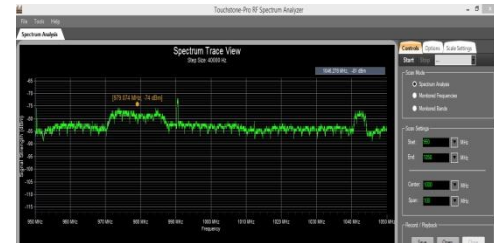


Ku band dish. Downlink
11.7-12.2 GHz



LNB down converts
(LO=10.750GHz)

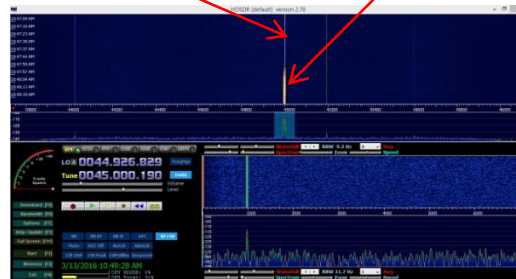
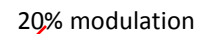
Rx frequency
=950-1450 MHz



Telstar 12 Transponder

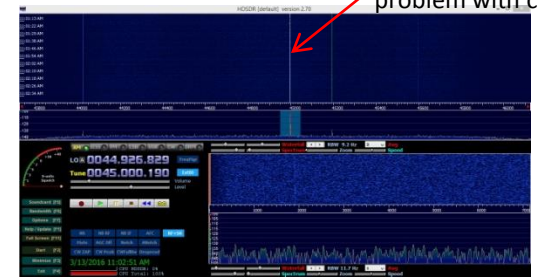
0% modulation

20% modulation

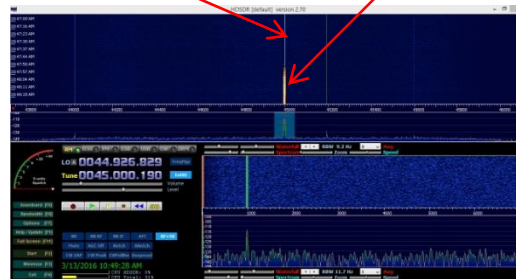


45 MHz signal, 1000Hz external modulation

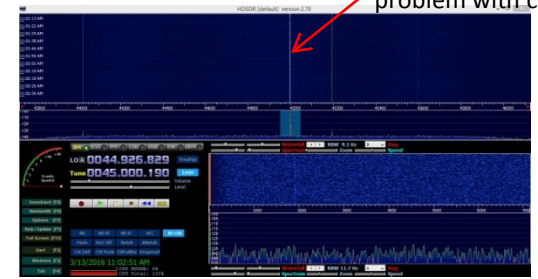
No modulation –
problem with circuit



45 MHz signal, 1000Hz internal modulation
Houston we have a problem!!!!!!



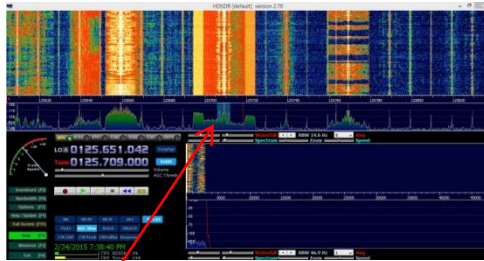
45 MHz signal, 1000Hz external modulation



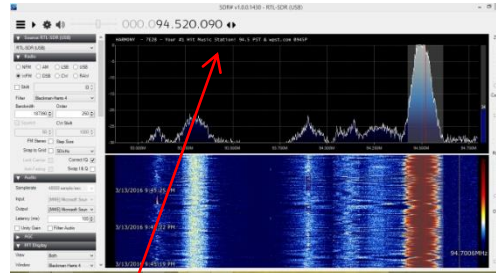
45 MHz signal, 1000Hz internal modulation
Houston we have a problem!!!!!!

Vintage Equipment Check out– Knight KG-686

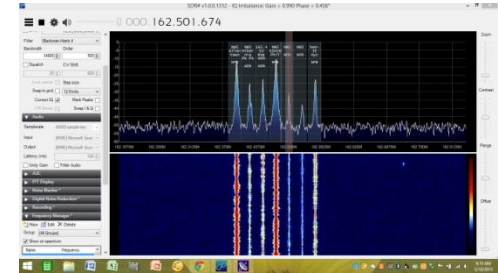
Wireless Waveform Screen Captures – Miscellaneous



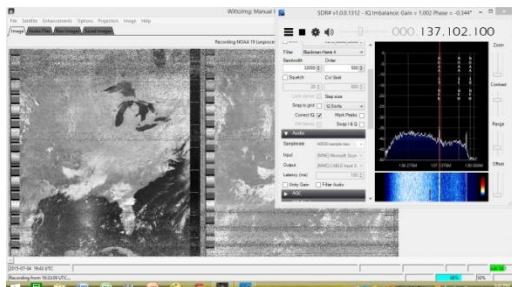
Hi Def (HD) Radio - WOR, 710 KHz



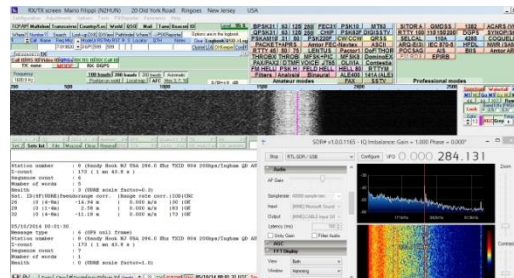
RDS (Radio Data System) – WPST -FM



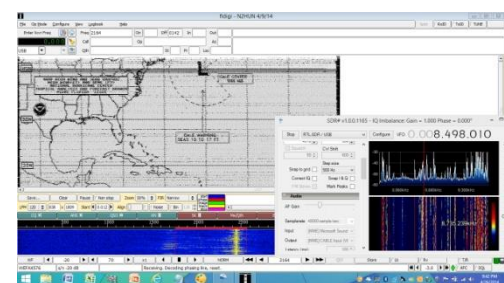
162.4-162.55 MHz NOAA Weather Stns.



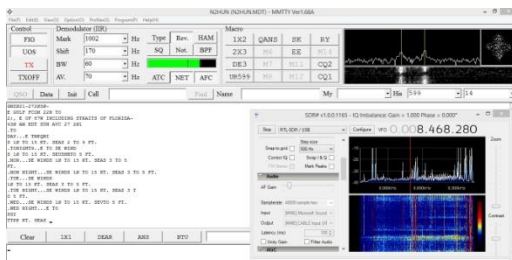
NOAA Weather Satellite + WXtoIMG



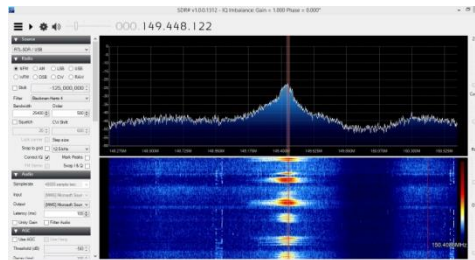
DGPS Beacon using MultiPSK



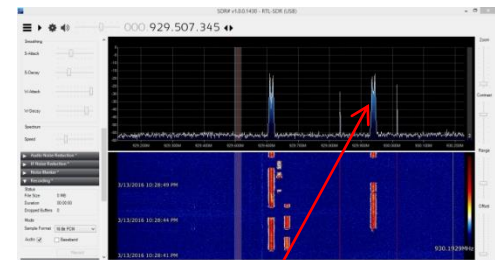
WEFAX Station – Fldigi Software



RTTY Signal decoded via MMTTY

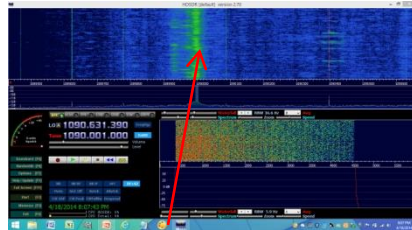


JLENS Radar Blimp



FLEX Pager

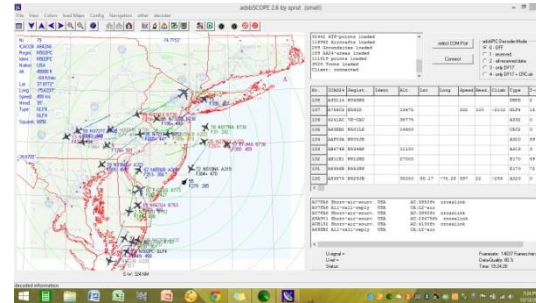
Wireless Waveform Screen Captures – Miscellaneous (cont'd)



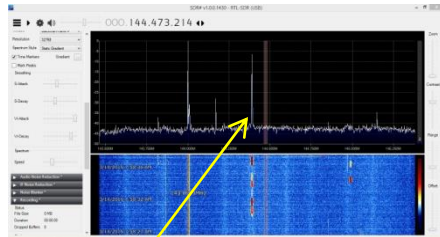
ADS-B on 1090 MHz



Transposed Coaxial Collinear Antenna



ADS-B Scope Software



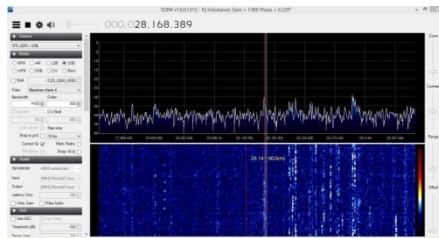
APRS – 144.390 MHz



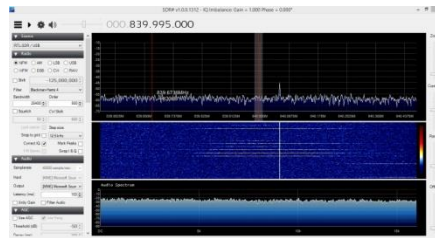
Wideband disccone



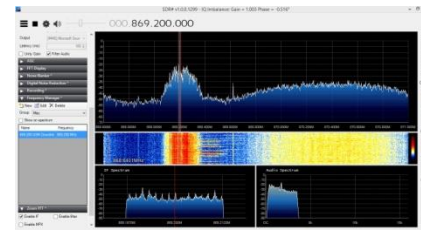
MultiPSK decoding



10m CW Beacons

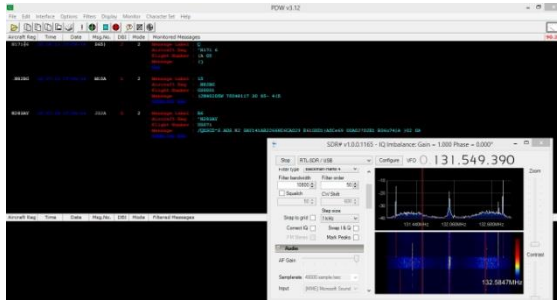


2G Cell phone - Dialing

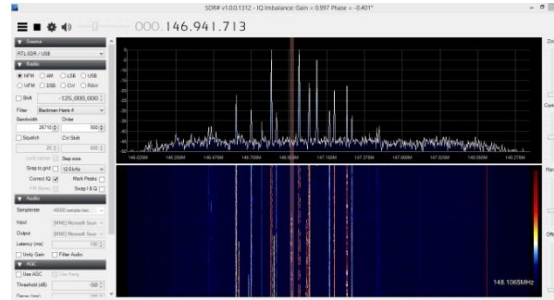


Cell phone tower (downlink)

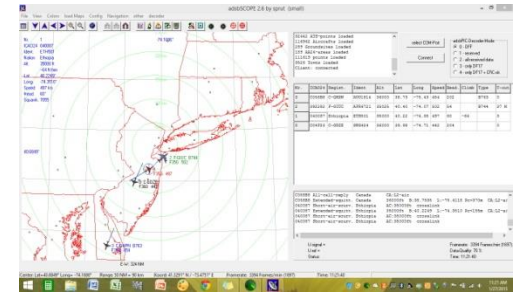
Even More Wireless Waveform Screen Captures – (cont'd)



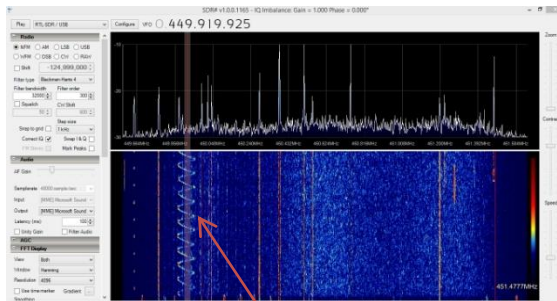
Decoding ACARS Using PDW



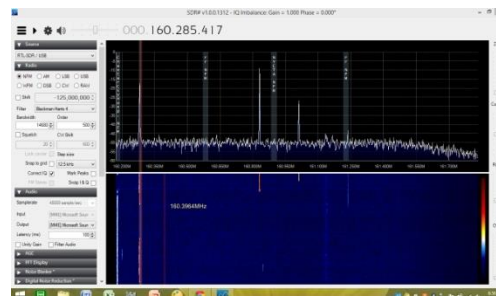
2m Ham Band During Jan. '16 Blizzard



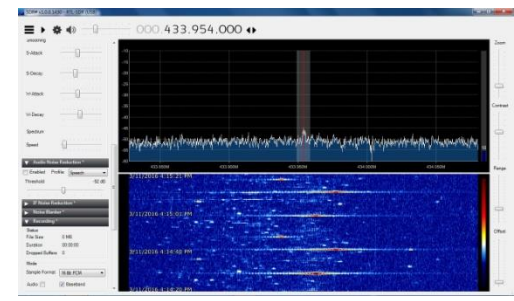
Air Traffic Band During Jan. '16 Blizzard



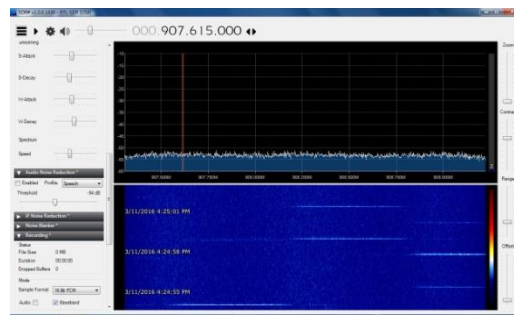
Weird "Corkscrew" Signal



Railroad Comms – 160-161 MHz

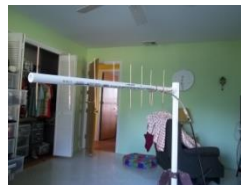


433 MHz ISM Band Cornucopia



900 MHz ISM Band Cornucopia

Antenna is very important!



Sources for SDR

- The Spectrum Monitor Magazine www.thespectrummonitor.com
- Monitoring Times back issues www.monitoringtimes.com
- QST back issues www.arrl.org/qst
- www.rtl-sdr.com
- www.hamradioscience.com
- www.rtl-sdr4everyone.blogspot.com
- www.greatscottgadgets.com (Hack RF One)
- www.YouTube.com
- www.Nooelec.com
- www.nutsaboutnets.com
- www.amazon.com
- www.ebay.com



Nooelec Up-converter



Covers 1MHz – 6 GHz!



www.thespectrummonitor.com

Are You a Victim of RWS (Radio Wave Sickness)?

- Symptoms
 - **Neurological:** dizziness ,irritability, headaches, insomnia, memory loss, psychosis
 - **Digestive:** nausea, abdominal pain
 - **Glandular:** enlarged thyroid, painful testicles, painful ovaries,
 - **Dermatological:** hair loss, rashes, redness of the skin
 - **Musculoskeletal:** tremors, spasms, numbness,/tingling, pain in the joints and feet
 - **Ophthalmological:** poor vision, cataracts, burning in the eyes, floaters
 - **Otological:** tinnitus (ringing in the ears)

